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THE APPALACHIAN RIVER *VERSUS* A TERTIARY TRANS-APPALACHIAN RIVER IN EASTERN TENNESSEE.¹

IN a very able and interesting paper, entitled "Geomorphology of the Southern Appalachians," by Hayes and Campbell,² considerable evidence is adduced in support of the theory that the drainage of the southern Appalachian valley up to late Tertiary time was through one rather large subsequent stream, occupying, in general, the position of the upper Tennessee and Coosa Rivers. This river, which ran down, as they believe, east of Lookout Mountain, over what is now the Tennessee-Coosa divide, and directly into the Gulf, has been called by them the Appalachian River. The evidence given for the existence of such a river is threefold: "(1) the perfectly base-leveled divide between the Tennessee and Coosa River basins; (2) a comparison of the volume of material eroded from the Appalachian valley with that of the Tertiary sediments in central Alabama; and (3) the immaturity of the Tennessee gorge through the plateau below Chattanooga."³

The three lines of evidence will be taken up in the order given above and examined briefly in the light of other facts furnished by this region, to see if the Appalachian River theory is the most tenable.

The Coosa-Tennessee divide.—It is admitted by Hayes and Campbell that similar low divides are found between other river basins of the Appalachian valley from Pennsylvania southward; as between the Potomac and the James, and the James and the Roanoke; but they do not believe that any great river ever flowed

¹The writer came to the view advocated in this paper in 1896, while engaged in the field under discussion. The paper was written in May, 1897 as a report in a course in physical geography in Harvard University given by Professor W. M. Davis. Publication has been delayed owing to a desire to make a more extended study of the problem in the field, but interest in other fields renders the making of such an examination improbable at an early date; it therefore seems best to present the paper in its original form.

²C. WILLARD HAYES AND MARIUS R. CAMPBELL, "Geomorphology of the Southern Appalachians," *National Geographic Magazine*, Vol. VI, pp. 63-126.

³*Ibid.*, p. 109.

over those divides. The Coosa-Tennessee divide is, however, wider and if peneplained by backward-cutting small streams, those streams, they believe, should have a "dendritic inosculating" arrangement.

By referring to the structural sheet of the "Ringgold Folio" of the *United States Geologic Atlas*, it will be seen that the width of the Coosa-Tennessee divide is easily explained by the structure of the region. The floor of this valley is almost entirely of Knox dolomite and a Cambrian shale both tilted at various angles, and always valley-making. It seems quite clear that, throughout this region, topography depends upon structure rather than upon the size of the streams. The width of the Coosa-Tennessee divide is limited only by the conglomerate- and sandstone-capped strata approaching horizontality. On the east, the resistant capping is Silurian; on the west, Carboniferous. A great river is evidently not necessary for the base-leveling of a region composed of the upturned dolomite and shales of this region. Cade's, Ware's and Tuckaleechee coves,¹ east of Chilhowee Mountain, are examples of this. The floors of these coves are of deformed dolomite and Wilhite slate, a very calcareous slate, and are lowered as rapidly as the streams can cut down their channels through the Chilhowee sandstone. These coves are surrounded by massive conglomerates, sandstones and slates, and the streams which drain them have their sources practically within the coves.

Dendritic branching of streams could hardly be expected in a region where the beds are varied in character (alternating harder and softer) and at the same time deformed into structures approaching parallelism, as these have been in this part of the Appalachian valley. Considering the structure and elevation of the region, it is difficult to conceive how the stream habit could be other than it is.

The volume of material eroded and deposited.—This evidence favoring the Appalachian River theory is briefly as follows: A stream occupying, in general, the present position of the Coosa-Alabama River is held responsible for the late Cretaceous and

¹ "Knoxville Folio," *U. S. Geologic Atlas*.

Tertiary sediments (Ripley, Lignite, Buhrstone, Claiborne, and White limestone) deposited in an area, limited on the east by a line midway between the Alabama and the Chattahoochee, and on the west by a line similarly drawn between the Alabama and the Tombigbee Rivers; sediments that occupy an area of 6,500 square miles and a volume of 2,340 cubic miles. The volume of material carried away from the basin of the Alabama and its tributaries between the Cretaceous and Tertiary peneplains is about 622 cubic miles; but if we add to this the volume carried from between the two peneplains in the upper Tennessee valley, the total amounts to 2,500 cubic miles.

If it be admitted that the only source of the Cretaceous and Tertiary sediments in the area named was from between the Cretaceous and Tertiary peneplains in the two river basins, and that this detritus was carried out in the direction named, the evidence is conclusive that the Appalachian River was a reality. But from the character of the coastal plain beds in this particular area, it is doubtful if the Alabama River, or its ancestor, should be held wholly responsible for the strata lying along its lower course. At least one-third of the thickness of these beds shown in outcrops is of limestone, bearing quantities of corals and other fossils.¹ The Alabama River cannot be held accountable for those deposits transported in solution or in a very finely divided state to the exclusion of the other rivers emptying into the Mississippi embayment. After the formation of the Nita crevasse in 1890, fine mud from the Mississippi River was deposited in Mississippi Sound even up to the mouth of Mobile Bay, driving out the fish and killing the oysters.² The thickest and most important of the beds attributed to the Appalachian River, the Lignitic (900 feet), is composed of cross-bedded sands and clays, and would seem, at first sight, more than all others, to have been deposited by this river; but a study of the whole area shows that this formation increases in thickness and in coarseness toward the west, in western Alabama and in Mississippi; while

¹ EUGENE A. SMITH, L. C. JOHNSON, AND DANIEL W. LANGDON, JR., *Report on the Geology of the Coastal Plain of Alabama* (1894), pp. 107 ff.

² *Ibid.*, p. 30.

east of the Alabama River it is very calcareous and "inconspicuous,"¹ showing that these sandy sediments were brought down from the west instead of from the north. Considering the nature and disposition of these sediments, and the decided notch in the Continental shelf nearly opposite Mobile Bay, and the tendency of the Gulf current to carry sediments eastward in this region, there seems no reason for believing that the Coosa-Alabama River was ever larger than it is at present.

Character of the gorge below Chattanooga.—It is claimed that this gorge is too immature to have been the channel of the Tennessee since Cretaceous time, or during the erosion of the upper Tennessee valley. It is admitted that erosion has progressed much more rapidly on the upturned strata of the valley, but it is thought impossible that the river could make so wide a valley along one part of its course and be held within such narrow limits lower down.

The rate of erosion in tilted soluble rocks, compared to that in horizontal beds of the same nature, capped by heavy beds of sandstone and conglomerate has never been definitely determined; but the contrast is undoubtedly strong. The Nashville basin has been eroded in strata only slightly domed, while the streams leading therefrom pass through gorges in horizontal strata having only a slight siliceous covering. It is a notable fact, in this connection, that the valley of the upper Tennessee is eroded back toward the west only just to the beginning of the horizontal strata, and where the horizontal strata have been reached the slope is as steep and the distance cut into the horizontal beds is no greater than in the Walden gorge; and moreover, the streams that run from the Walden plateau east into the great valley have proportionally as narrow gorges with as steep slopes as has the Tennessee in its gorge. If the Appalachian River existed and the valley is older than Walden gorge, these side gorges are also older, and, according to this reasoning, should be wider; for the streams, although small, apparently carry all the waste brought to them. The wide coves on the eastern side of the valley made by small streams on upturned dolomite, and pre-

¹*Ibid.*, p. 148.

sumably of the same age as the gorges on the west, have already been noted.

It appears, then, that evidence favoring the existence of the Appalachian River is small, although this has been the view of some observers for more than twenty years. Long,¹ in his report of the survey of the Tennessee and Holston Rivers in 1875, states this as his view, but gives little evidence for its support.

A trans-Appalachian river.—What seems to the writer a more tenable view of the history of the drainage of this part of the Appalachian province follows. Up to the close of Cretaceous time the rivers flowed off toward the northwest from the axis of the Great Smoky Mountains, or in general, at right angles to this axis; and the more nearly base-leveled the Cretaceous peneplain became, the more the streams meandered upon it. The headwaters of these old rivers, which cut directly across the strike of the present valley strata, are now represented by the Doe-Watauga, Nolichucky, French Broad, Big and Little Pigeons, Little River, Little Tennessee, upper Tellico, Hiwassee, Ocoee, and upper Connasauga. After the uplift of the Cretaceous peneplain, by differential erosion the great valley began to be formed, and lateral subsequent branches pushed their way back along the strike of the valley-making strata. The uplift being greater in the northern part, the south-flowing subsequent streams, being the more accelerated, have cut back more rapidly than those flowing toward the north, and have made practically all the captures in this region. This process of capturing has gone on until now all the original transverse streams have been turned from their courses across the Cumberland plateau southward into the Tennessee River, which alone maintains its course across the Walden plateau. The upper course of the original Walden gorge river has already been taken south by the Connasauga, while the Tennessee awaits a friendly pirate to conduct it south directly into the Gulf through a shorter and easier course. That the position of the master stream has been west of Lookout Mountain rather

¹ LIEUTENANT-COLONEL S. H. LONG, "Report Relative to the Improvement of the Navigation of the Holston and Tennessee Rivers," *House Executive Document*, Forty-Third Congress, Second Session, Vol. XV, No. 167, p. 16.

than east of it for a long period is indicated by the westward drainage on Walden plateau south of the gorge. The character of the Tertiary sediments in Alabama, as pointed out on a previous page, indicates that the larger streams entered the Mississippi embayment west of the Alabama River. The mature swing of Walden gorge also suggests that the course of the river was established here when the region was nearly at base-level, previous to the uplift of the Cretaceous peneplain.

A consideration of the failure to find any satisfactory process by which a stream, when once established in this easily eroded valley and flowing directly into the sea, could be diverted across Walden's Ridge, together with the foregoing facts, renders the existence of a Tertiary river across the present valley and along the course of Walden gorge more probable than that of a Tennessee-Coosa, or Appalachian River.

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